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㉓ Protracted-release microbiocidal articles containing relatively high water solubility microbiocides.

㉔ A membrane, permeable to water, and impermeable to microbiocidal compounds contains therein a solid particulate microbiocidal composition which is useful in aqueous systems, comprising a relatively highly water-soluble (more than 1000 ppm at room temperature i.e. 25 °C) a microbiocidal compound and inert, finely-divided water-insoluble solid carrier therefor, the membrane being made from a film-forming material having a solubility parameter less than 12.5. Especially useful microbiocides are 3-isothiazolones and 2-substituted-1,2-benzisothiazolones, and metal salt stabilized derivatives thereof, preferably absorbed into siliceous diatomaceous earth in a sealed, perforated membrane, for example, a perforated bag, produced from polyethylene. Microbiocides of lower solubility can be included in the microbiocidal composition provided that the total microbiocide has a water solubility more than 1000 ppm at room temperature.

㉕ A safer form of active ingredient known to be relatively irritating to human skin when in high concentration in aqueous solution is provided as are method for controlling microorganisms and for effecting protracted release of the microbiocide in aqueous media, using the articles.

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PROTRACTED RELEASE MICROBIOCIDAL ARTICLES CONTAINING
RELATIVELY HIGH WATER SOLUBILITY MICROBIOCIDES, THEIR USE IN
THE CONTROL OF MICROORGANISMS, IN PROTRACTED RELEASE OF
MICROBIOCIDE INTO AQUEOUS SYSTEMS AND IN SAFENING

5 MICROBIOCIDAL COMPOSITIONS

This invention is concerned with protracted release
microbiocidal articles containing relatively high water
solubility microbiocides, their use in the control of
10 microorganisms, in protracted release of microbiocide into
aqueous systems and in safening microbiocidal compositions.

The microbiocidal articles with which the invention is
concerned comprise microbiocidal composition sealed in a
porous membrane. Microbiocides of special interest are the
15 microbiocidal 3-isothiazolones and 2-substituted-1,2-
benzisothiazolones (hereafter "isothiazolones"). The
isothiazolones have a tendency to cause skin irritation in
man and to evolve nontoxic gases when in aqueous solution at
concentrations convenient for shipping.

20 Isothiazolones are a class of chemical compounds known
to possess excellent and useful microbiocidal properties and
resistance to common additives and contaminants. Many
3-isothiazolones are disclosed in U.S. Patents 3,761,488;
3,849,430; 3,870,795; 4,067,878; 4,150,026; and 4,241,214.
25 U.S. Patents 3,517,022, 3,065,123; and 3,761,489 disclose
2-substituted-1,2-benzisothiazolones. U.S. Patent 3,849,430
discloses a method for preparing the isothiazolones.

While the above-mentioned patents disclose the use of
isothiazolones in a variety of microbiocidal end uses, such
30 as, for example, those uses and formulations and
compositions disclosed in U.S. Patent 3,761,488 at columns
15-19 and in the actual examples thereafter, isothiazolones
are generally made available in combination with a liquid
carrier such as water or in aqueous compositions. Column 19,
35 line 66 et seq. discloses that isothiazolones can be taken
up or mixed with a finely-divided particled solid carrier,
as for example, clays, inorganic silicates, carbonates,

silicas and organic carriers. Column 20, line 25 et seq. discloses that a convenient method for preparing a solid formulation is to impregnate the isothiazolone onto the solid carrier by means of a volatile solvent, such as 5 acetone. However, these earlier attempts to produce solid formulations have resulted in formulations which tended to coalesce (or "cake") or to give extremely lightweight particles (or "dusts").

U.S. Patent 3,977,404 discloses an osmotic device for 10 delivering an active agent to an external fluid present in the environment of use at a controlled and continuous rate comprised of a shaped wall, which is made in at least a part of a material permeable to an external fluid and substantially impermeable to active agents, surrounding at 15 least part of a reservoir containing an active agent. The reservoir is formed of a microporous material permeable to the active agent and the external fluid. The micropores in the reservoir constitute a passageway for dispensing active agent from the reservoir to the external fluid in the 20 environment of use wherein the external fluid is continuously imbibed through the wall into the reservoir in a tendency towards osmotic equilibrium at a rate determined by the permeability of the wall and the osmotic pressure gradient across the wall to continuously dissolve active 25 agent to provide a substantially saturated solution of active agent which is delivered through the passageway from the device. The material for fabricating the wall is selected from materials which can be substantially insoluble in fluids or which can bioerode after a period of time 30 taking place at the end of the active agent release period. Exemplary suitable wall materials include cellulose acetate and similar cellulose esters and cellulose ethers, hydroxylated ethylene-vinyl acetate; perm-selective aromatic nitrogen containing polymeric membranes that exhibit water 35 permeability and essentially no solute permeability, semi-permeable membranes made from polymeric oxides; and the like. Suitable microporous material to produce the

reservoir include polymeric materials such as polycarbonates, poly(vinyl chloride), polyamides, polysulfones, crosslinked olefin polymers, and hydrophobic or hydrophilic microporous homo-, co- and interpolymers. The examples teach only reservoirs produced from polymeric 5 materials. Exemplary active agents include, for example, pesticides, herbicides, germicides, biocides, algicides, insecticides, anti-oxidants, plant growth promoters and inhibitors, disinfectants, catalysts, chemical reactants, nutrients, cosmetics, drugs, sex sterilants, air purifiers, 10 and other agents which benefit the environment of use.

The devices of the patent are made by standard techniques. For example, one suitable technique is to form the reservoir by blending a polymeric powder with an active agent in crystalline or granular form and then applying 15 pressure to convert the blend into a solid having agent embedded therein followed by applying the wall by spraying, dipping, casting, coating, solvent evaporation, molding, or pressing the wall-forming material to the reservoir. The opening in the wall can be formed by covering a part of the 20 wall with tape that is removed after the wall is coated onto the reservoir, by cutting away a part of the wall, or by punching an opening in the wall to connect a microporous path of the reservoir with the exterior of the device.

U.S. Patent 4,011,172 discloses articles designed to 25 bleach fabrics in an automatic dryer comprising chlorine bleaching compounds dissolved in water or other suitable solvent thickened by the addition of particulate thickening agent, for example, silicate materials, water-swellable and water-soluble polyacrylamides and cellulose derivatives, and 30 synthetic clays, the thickened bleaching compounds being contained in a perforated pouch made of plastic material until use, at which time the total contents of the pouch will be disseminated. The pouch comprises a flexible, embossed, water-insoluble plastic sheeting made by folding 35 the embossed sheet into the pouch-like configuration and sealing, for example, heat-sealing, the edges, leaving an

opening along one edge. After adding the bleaching composition to the pouch through the opening, the opening is then sealed. The resulting pouch is stretched immediately prior to use to cause pores or perforations along the 5 embossing lines. Suitably embossed plastic sheets for preparing the pouch receptacle include sheets of, for example, polyethylene, polypropylene, and the like, and are available from Hercules as INSTANTNET and DELNET brand. When ruptured along the embossed pattern lines, such sheets 10 form pores or perforations in the size range of 0.05 mm.-3 mm. Alternatively, water-insoluble plastic pouches having perforations in the size range of about 0.05 mm.-3 mm. can be used. Such pouches can be covered and sealed with plastic film which is removed at the time of use.

15 U.S. Patent 4,170,565 discloses a substrate article for cleaning fabrics, particularly in an automatic washer, consisting essentially of an effective amount of a surface-active composition of about 5-95% by weight of a water-soluble surface-active agent contained between two 20 layers of a water-insoluble, wet-strength substrate, at least one of said layers having an air permeability of at least about 10 ft.³ of air per minute per ft.² of substrate. The perimeter of the two sheets are sealed together, such as by adhesive, sewing, or heat sealing.

25 Preferred substrates include flexible water-insoluble, wet-strength paper, woven cloth, and non-woven cloth substrates, cellulose ester being mentioned among a list of synthetic fibers suitable for making non-woven cloths.

30 U.S. Patent 4,289,815 discloses a pouch for the controlled release of active ingredients into an aqueous medium comprising liquid or solid active ingredients enclosed in a sealed envelope of cold-water insoluble polyvinyl alcohol. The object of the invention described in the patent is to provide pouches for delivery of active 35 ingredients which provide a substantially uniform, controlled "zero-order" release of the active ingredients. This objective is achieved by utilizing cold-water

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insoluble, gas-impermeable polyvinyl alcohol as the polymeric film for preparing the pouches. The patent further discloses that a wide variety of liquid and solid active ingredients are applicable for use in the pouches, 5 examples of which active ingredients include detergents, bleaches, chlorinating agents, pesticides, bactericides, dyes, drugs, and other chemicals. At column 3, lines 53 et seq., the patent teaches that "in order to establish practical release rates, it is required that the active 10 ingredient exhibit a minimum water solubility" and that the water solubility can range from small water solubility to total water solubility. The patent also teaches that the applicable areas of use include introduction of active ingredients into toilet tanks, urinals, swimming pools, and 15 water towers.

Isothiazolones are commonly provided in commerce in aqueous solution, usually with inorganic, alkaline earth metal salts as stabilizers to prevent reactions which render them inactive against microorganisms. Although solid 20 alkaline earth metal salt complexes of isothiazolones are known (U.S. Patents 4,150,026 and 4,241,214 mentioned above), these salt complexes suffer the disadvantage that they badly corrode processing equipment used to remove water in the course of producing the solid dry salt complex 25 product, and the final solid salt complex product tends to be extremely dusty and thereby toxic to one during handling the product.

A typical, useful commercially available 30 3-isothiazolone product is a metal salt-stabilized aqueous solution of 5-chloro-2-methyl-3-isothiazolone and 2-methyl-3-isothiazolone (3:1) containing 14% active ingredient and $Mg(NO_3)_2$ plus $MgCl_2$ as stabilizers. Such commercial products suffer the disadvantages of being 35 irritating to the skin when spilled during handling and evolving nontoxic gases which build up pressure in a sealed container provided for shipping and transportation.

This invention can be used to provide an improved

microbiocidal, especially isothiazolone-containing, article for delivery of water-soluble, microbiocidally-effective compounds to aqueous systems wherein said article has reduced, if any at all, tendency for a water-soluble

5 microbiocidal, especially isothiazolone, compound to accumulate on the external surface thereof, especially over a period of time which approximating to a shipping and storage period.

Other biocides which may be employed include quaternary

10 ammonium compounds such as N-alkyl dimethylbenzylammonium chloride and the like dithiocarbamates such as 1,2-ethanediylbiscarbamodithioic acid disodium salt, sodium methyldithiocarbamate and the like, triazine such as hexahydro-1,3,5-tris-(2-hydroxyethyl)-S-triazine and the

15 like and mercapto pyridines and zinc derivatives thereof such as sodium pyridinethione and the like.

We have now found that a porous (or perforated) membrane, for example, a film or sheet of relatively hydrophobic film-forming material, wherein the pores (or perforations) are smaller than the particle size of solid, particulate microbiocidal composition sealed therein, which composition comprises inert, finely-divided water-insoluble solid carrier material admixed with a water-soluble microbiocidal compound, especially a water-soluble

25 isothiazolone compound usually in aqueous solution, can be used to make the microbiocide effectively available in aqueous media without allowing the carrier material to pass through the pores and while combatting to a surprising degree any tendency for the microbiocide, especially

30 isothiazolone, to migrate through the membrane material and accumulate on the external surface of the membrane. The production of microbiocidal articles useful for storing, handling, transporting, and delivering a microbiocidal compound to an aqueous system is thereby enabled. An especially suitable microbiocidal article comprises the microbiocidal compound, especially isothiazolone, in solid form contained in a bag, or packet, of the membrane.

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One aspect of this invention is, therefore, a method for safening the handling of microbiocidal compounds. Another is the control of microorganisms in aqueous media and yet another is the protracted release of microbiocide 5 into aqueous media. The articles of the invention however comprise

(a) a particulate solid microbiocidal composition comprising:

10 (i) 0.1 to 70 weight %, based on total weight of said composition, of water-soluble microbiocide having a room temperature (25°C) water solubility greater than 1000 ppm, blended with and absorbed into;

15 (ii) 99.9 to 30 weight %, based on total weight of said composition, of inert, finely-divided water-insoluble solid carrier material; sealed in

20 (b) a porous membrane of hydrophobic film forming material having a thickness of 1.27×10^{-5} m (0.5 mil) to 25.4×10^{-5} m (10 mils), a solubility parameter less than 12.5 and a pore size smaller than the effective particle size of the solid microbiocidal composition. The preferred pore diameter of the membrane is equal to or less than 15.24×10^{-5} m (6 mil) and more especially those having a pore diameter of about 12.7×10^{-5} m (5 mil).

25 Suitable hydrophobic, film-forming materials are polyesters, polyfluoroolefins, polyamides (Nylons), polyvinyl chloride, polyethylene, polypropylene, spunbonded polyethylene, spunbonded polypropylene, polyethylene terephthalate, or polycarbonate.

30 Microbiocides or biocides, especially those isothiazolones which have high water solubility and which have been found to be especially useful, preferably are absorbed into the inert, finely-divided, water-insoluble solid carrier material from aqueous solutions, in which form the isothiazolones are ordinarily obtained from conventional 35 production processes. When it is desirable to package the particulate, solid microbiocidal isothiazolone composition of the aqueous solution of the isothiazolone absorbed into

the solid carrier material, the film-forming membrane material used to envelope the composition to form the article or packet must possess the characteristic that the water of absorption containing dissolved isothiazolone will 5 not migrate from the interior of the article through the membrane material to the external surface of the article so as to result in an accumulation of the isothiazolone on the external surface of the article. A hydrophobic material is best suited for preventing aqueous solutions containing 10 isothiazolones which may leach-out from the composition to migrate from the interior of the article to the external surface. However, continuous films of hydrophobic materials used as the membrane for the article will permit only small amounts of aqueous solutions containing isothiazolones to 15 migrate from the interior to the exterior surface of the article and permit only small amounts of external water to migrate from the external environment of use of the article into the interior of the article. Thus, such continuous films of hydrophobic material permit the release of only 20 small amounts of the microbiocidal isothiazolones from the composition to the external aqueous system which constitutes the environment of use. Although continuous films of hydrophobic material are useful to produce articles which will provide protracted release of small amounts of 25 isothiazolones to effect low concentrations thereof in the environment of use, such films are not suitable to effect higher concentrations of isothiazolones in the environment of use.

This problem is overcome by the use, for the article 30 membrane, of a porous, including perforated, film or sheet produced from hydrophobic film-forming material. The pores, or perforations, may be effected by punching holes in the film or sheet, or by a method of manufacture of the film or sheet which will impart pores or perforations to the film or 35 sheet, for example, weaving or spunbonding manufacturing methods. The only limitation concerning the pore size is that it be

sufficiently smaller than the particle size of the particulate, solid microbiocidal isothiazolone composition so as to not permit the composition to pass from the interior of the article through the pores to the external 5 environment of use. Pore sizes in the range of from 10.16×10^{-5} m to 17.78×10^{-5} m (4 to 7 mils) are generally preferred.

The surprising property of the article of the invention is that when the article is used in an aqueous system, water 10 freely migrates through the membrane pores into the interior of the article and dissolves the water-soluble microbiocides from the composition and migrates as an aqueous microbiocide solution back into the aqueous system. This converts the initial aqueous system into a solution containing 15 microbiocidally-effective amounts of biocides released from the article. This same article, when dry prior to use, does not permit migration of the absorbed aqueous solution of the microbiocide from the interior of the article to accumulate on the external surface of the article even over a period of 20 time which approximates shipping or transporting and storage time under normal room conditions of relative humidity and temperature, notwithstanding the presence of water of absorption in the composition and the pores in the enveloping membrane or packet material.

25 It will be apparent to those having ordinary skill in the pertinent art that the porous membrane of hydrophobic material is also useful to produce articles according to this invention wherein the particulate, solid microbiocidal isothiazolone composition is produced from solutions of the 30 water-soluble isothiazolone component dissolved in water or in a volatile organic solvent absorbed onto the carrier material followed by removal, by conventional means of evaporation, of the water or the volatile organic solvent before the composition is enveloped or sealed in the porous 35 membrane or packet material. In this embodiment, this invention is also advantageous in that the use of the porous film of hydrophobic material prohibits the accumulation of

the isothiazolone component in aqueous solution on the external surface of the article wherein the water provided by the storage environment, that is, humid air, is permitted to migrate from the external storage environment through the 5 porous membrane into the interior of the article, but no resulting aqueous isothiazolone solution formed in the interior of the article is permitted to migrate back through the membrane to the external surface of the article.

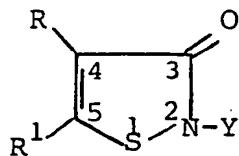
Thus, the article according to this invention can 10 provide a still safer form of water-soluble biocides, especially isothiazolones, useful in aqueous systems, which form is characterised by reduced risk of contact of the biocide, especially isothiazolones, in aqueous solution with the skin.

15 Desirable ranges of hydrophobicity of film-forming material useful for producing the article membrane are set forth below:

Article		
<u>Desirability</u>	<u>Membrane Material</u>	<u>Solubility Parameter</u>
20 Poor		>12.5
	eg, polyvinyl alcohol, cellulose	12.6
		15.6
Preferred		10-12.5
	eg, polyamide, polyvinyl chloride	12
25		12.2
More Preferred		8-10
	eg, polyethylene terephthalate, polycarbonate	9.5
		9.5
30 Most Preferred		<8
	eg, polyethylene, polypropylene	7.8
		7.8

35 Preferably, in the particulate, solid microbiocidal isothiazolone composition used according to the invention, the water-soluble microbiocidally-effective isothiazolone

(i), having a room temperature (25°C) water solubility of greater than 1000 ppm, comprises isothiazolone of the formula



wherein

5 Y is an unsubstituted or substituted C_1 - C_{18} alkyl group, an unsubstituted or substituted C_2 - C_{18} alkenyl or alkynyl group, an unsubstituted or substituted C_3 - C_{12} cycloalkyl group, an unsubstituted or substituted aralkyl group of 6-10 carbon atoms, or an unsubstituted or 10 substituted aryl group of 6-10 carbon atoms;

10 R is hydrogen, halogen or a C_1 - C_4 alkyl group;

15 R' is hydrogen, halogen or a C_1 - C_4 alkyl group, or R and R' can be taken together with the C=C bond of the isothiazolone ring to form a benzene ring;

15 or said isothiazolone(s) stabilized with at least one metal salt in an amount of 1 - 60 weight % based on weight of isothiazolone and metal salt, said metal salt(s) being represented by the formula:



wherein

20 M is a cation of sodium, potassium, calcium, magnesium, copper, iron, zinc, barium, manganese, silver, cobalt and/or nickel;

25 X is chloride, bromide, iodide, sulfate, nitrate, nitrite, acetate, chlorate, perchlorate, bisulfate, bicarbonate, oxalate, maleate, p-toluene-sulfonate,

carbonate, and/or phosphate; and

n is an integer for which the anion X satisfies the valence of the cation M;

and, said solid carrier material (ii) comprises inert,

5 finely-divided water-insoluble solid material selected from silicaceous diatomaceous earth, high water absorption capacity calcium silicate granular material, silicas, charcoal, clays, vermiculite, corn cobs, high purity silica (e.g. Aerosil and Sipernet), wood (sawdust), polymeric 10 matrices, such as ion exchange resin beads.

It is to be understood that, as the number of carbon atoms in the substituent group "Y" increases, and as halogens are substituted on the isothiazolone ring, water-solubility decreases.

15 By a "substituted alkyl group" is meant an alkyl group having one or more of its hydrogens replaced by another substituent group. Examples of the substituted alkyl groups which characterize the isothiazolones preferably used in this invention include hydroxyalkyl, haloalkyl, cyanoalkyl, 20 alkylamino, dialkylamino, arylaminoalkyl, carboxyalkyl, carbalkoxyalkyl, alkoxyalkyl, aryloxyalkyl, alkylthioalkyl, arylthioalkyl, haloalkoxyalkyl, cycloaminoalkyl such as morpholinylalkyl and piperidinylalkyl and pyrrolodinylalkyl, carbamoxyalkyl, alkenyl, haloalkenyl, alkynyl, haloalkynyl 25 and isothiazolonylalkyl.

By a "substituted aralkyl group" is meant an aralkyl group having one or more of the hydrogens on either the aryl ring or the alkyl chain replaced by another substituent group. Examples of the substituted aralkyl group which characterize the isothiazolones used in this invention 30 include halo, lower alkyl and lower alkoxy.

35 By a "substituted aryl group" and "substituted benzene ring" is meant an aryl group and benzene ring, respectively, such as phenyl, naphthyl, or pyridyl groups, having one or more of the hydrogens on the aryl ring replaced by another substituent group. Examples of such substituent groups

include halo, nitro, lower alkyl, lower alkoxy, lower alkyl- and acylamino, lower carbalkoxy and sulfonyl.

By the expression "water-soluble" as applied to the isothiazolones used in this invention is meant an 5 isothiazolone or combination of isothiazolones characterized by having a water solubility greater than 1000 ppm (0.1%) at room temperature (25°C). Especially preferably, the isothiazolone or combination thereof is characterized by having a room temperature water solubility greater than 10 50,000 ppm. An example of a suitable highly water-soluble combination of isothiazolones is the commercially available 3-isothiazolone product, 5-chloro-2-methyl-3-isothiazolone and 2-methyl-3-isothiazolone in a weight ratio of 3:1 with 15 weight % Mg (NO₃)₂ and 9 weight % of Mg Cl₂, whose 15 water solubility is about 150,000 ppm. The isothiazolone may have a water solubility even approaching infinite solubility.

By the expression "microbiocidal compound" is meant those compounds effective to control those microorganisms 20 especially of the group of bacteria, fungi (including molds and yeasts), and algae. In the method of the invention for controlling living microorganisms, by the expression "microorganisms" is meant bacteria, fungi (including molds and yeasts), and algae.

25 When used alone, the expression "isothiazolone(s)" is meant to include the "free" isothiazolone(s) and the metal salt complexes of the free isothiazolone(s).

More preferably in the methods and article of the invention, the particulate, solid, microbiocidal 30 isothiazolone composition comprises (i) 1 to 35 weight %, based on total weight of said composition, of said water-soluble isothiazolone wherein

Y is an unsubstituted or substituted C₁-C₁₈ alkyl group or C₃-C₁₂ cycloalkyl group;

35 R is hydrogen or halogen;

R' is hydrogen or halogen; or

R and R' are taken together with the C=C bond of the isothiazolone ring to form a benzene ring;

or said isothiazolone stabilized with said metal salt;

5 and (ii) 99 to 65 weight %, based on total weight of said composition, of a solid carrier material selected from silicaceous diatomaceous earth, high water absorption capacity calcium silicate granular material, silicas and clays.

10 Most preferably in the methods and article of the invention, the particulate, solid, microbiocidal isothiazolone composition comprises (i) 2 to 25 weight %, based on total weight of said composition, of said water-soluble isothiazolone wherein Y is methyl, R is 15 hydrogen and R' is chlorine; or of a mixture of said isothiazolones in aqueous solution wherein Y is methyl, R is hydrogen and R' is chlorine and Y is methyl, R is hydrogen and R' is hydrogen; or said isothiazolone(s) stabilized with said metal salt wherein said metal salt is $Mg(NO_3)_2$ or a 20 mixture of $Mg(NO_3)_2$ and $MgCl_2$; and (ii) 98 to 75 weight %, based on total weight of said composition, of silicaceous diatomaceous earth.

By way of example, there may be used in combination with the above-defined 3-isothiazolone commercial product, 25 an isothiazolone having a water-solubility of about 500 ppm wherein Y is n-octyl or t-octyl and R and R' are both hydrogen, providing, of course, that the water solubility of the combination is greater than 1000 ppm.

The preparation and properties of representative 30 isothiazolones are described in U.S. Patents 3,517,022; 3,761,488; and 3,065,123. U.S. Patent 3,849,430 further discloses a process for the preparation of representative isothiazolones. U.S. Patents 3,870,795 and 4,067,878 describe metal salt stabilized solutions of 3-isothiazolones 35 which are useful according to this invention. Additional

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isothiazolones which are useful according to the invention are those disclosed in U.S. Patent 4,310,590.

Preferably, the finely-divided, water-insoluble solid carrier material is selected from silicaceous diatomaceous 5 earth, high water absorption capacity calcium silicate material, silicas, clays, and polymeric matrices.

Suitable silicaceous diatomaceous earth material is described in the Johns-Manville Corporation Technical Bulletin FF-160A, 10-80 concerning Celite Diatomite Filter 10 Aids and Natural, Calcined, and Flux-Calcined Grades thereof. Suitable high water absorption capacity calcium silicate material is commercially available under the trademark "Micro-Cel" from the Johns-Manville Corporation. Typical as polymeric matrices useful as carrier material are 15 adsorbents and ion exchange resins, such as, for example, Amberlite XAD-4 (a styrene/divinylbenzene polymeric adsorbent resin); Amberlite XAD-7 and Amberlite XAD-8 (acrylic adsorbent resins); Amberlite 200 (a sulfonated styrene/divinylbenzene ion exchange resin); Amberlite 20 IRA-900 (a styrene/divinylbenzene strong base ion exchange resin), and Amberlite IRC-50 (a weak acid ion exchange resin).

Especially preferred is a diatomaceous earth material commercially available as Celite 545 (Johns-Manville 25 Corporation).

Of course, conventional adjuvants and additives used in microbiocidal compositions and formulations may be incorporated into the solid microbiocidal composition for example by first dissolving them in the aqueous or inert 30 organic solvent solution of the isothiazolone(s) and then blending the solution with the solid carrier material. One useful additive for use in the solid microbiocidal composition according to the invention is a dye which would impart a readily visible colour to the solid composition. 35 Thus, whenever, as a result of the accidental rupture of the

article according to the invention, any solid microbiocidal composition would accidentally be spilled onto the skin during handling, the spilled composition could readily be observed and removed before the toxicant could leach out of 5 the solid and cause skin burns. This is in contrast to the case involving accidental spillage of the aqueous microbiocidal solution of the isothiazolone when handling in association with an aqueous system, in which case it would be difficult to distinguish between harmless aqueous system 10 and toxic isothiazolone concentrate. Other useful adjuvants and additives include chelating agents, surfactants, dispersants and buffers.

Alternatively, other conventional adjuvants and additives used with the isothiazolones which are used 15 according to this invention may be combined with the microbiocidal composition in the sealed membrane independent of incorporation into the microbiocidal composition.

The article of the invention may be used advantageously in metal-working fluids, swimming pools, water towers such 20 as water cooling towers, toilet bowl water, washing machine water.

For use in metal-working fluids, swimming pools, water towers, such as water cooling towers, toilet bowl water and washing machine water, the article of the invention can 25 conveniently be removed from its shipping container, placed into the aqueous system to be treated, and, when the microbiocidal compound has completely leached-out of the article, the sealed membrane containing the solid carrier material can be safely removed by conventional techniques, 30 for example, by hand, using tongs to dip the sealed membrane from the aqueous system.

The following Examples illustrate some embodiments of the invention. All parts and percentages therein are by weight unless otherwise indicated and all temperatures are 35 in degrees Centrigrade unless otherwise indicated.

Example 1

To 75 g. of Celite 545 in a glass bottle was added 75 g. of 5-chloro-2-methyl-3-isothiazolone blended with 2-methyl-3-isothiazolone in a weight ratio of 3:1 (approx) 5 with 15 weight % $Mg(NO_3)_2$ and 9 weight % of $MgCl_2$ in aqueous solution containing 14% active ingredient. The mixture was then stirred by hand with a spatula until it appeared to be uniformly mixed and free-flowing. No drying by heating was required or desired. The resulting solid 10 product contained one-half of the initial amount of active ingredient ("AI") per unit weight of product, that is, the solid composition contained 7 weight % of active ingredient. The resulting solid microbiocidal composition was stored in a sealed bottle for several days at room temperature. 15 Thereafter, when the stopper was removed, there was observed no gas emission due to pressure build-up.

1.6 g. of the resulting solid microbiocidal composition was added to 1000 ml. of water to give 1001.6 g. total weight of water and solid microbiocidal composition. 20 Analysis of the supernatant water by ultraviolet spectroscopy indicated that all of the microbiocide was released into the water within 5 minutes.

Example 2

A solid microbiocidal composition containing 20 weight 25 % of active ingredient was prepared by dissolving 2.66 g. of crystalline 5-chloro-2-methyl-3-isothiazolone in 15 ml. of methanol. To this solution there was added 0.6 g. of $Mg(NO_3)_2 \cdot 6 H_2O$. The resulting solution was added to 10 g. of Celite 545 in a 4 fl. oz. bottle and the mixture 30 was stirred by hand using a spatula until it appeared to be uniformly mixed and free-flowing. Methanol was removed by air-drying (or by heating the mixture under reduced pressure), and a uniform, free-flowing particulate solid was obtained. The solid was stored in a sealed bottle for 35 several days at room temperature and thereafter, when the

stopper was removed, there was observed no gas emission due to pressure build-up resulting from gas evolution from the solid composition. Upon adding the solid composition to water, all of the isothiazolone was released within 10 5 minutes.

Example 3

This example illustrates the property of the solid microbiocidal composition whereby the solid composition tends not to evolve gasses to the extent that the known 10 aqueous solutions of 3-isothiazolones evolve gasses even after heat treatment to eliminate volatile components.

The solid compositions were prepared as follows:

Water was partially removed from Kathon 886 aqueous 15 concentrate under reduced pressure (65° C/40 mm Hg), and solid carrier material (Celite 545, available from Johns-Manville Corporation; Attaclay X-250, available from the Minerals and Chemicals Corporation of America, Attapulgus Clay Products, HiSil T-600, available from 20 Pittsburgh Plate and Glass Company; or mixtures thereof) was added to the residue to obtain a flowable solid composition.

The table below describes the formulation and properties of representative compositions.

SOLID FORMULATIONS FROM A 3:1 (approx) WEIGHT MIXTURE OF
5-CHLORO-2-METHYL-3-ISOTHIAZOLONE and 2-METHYL-ISOTHIAZOLONE,
14% ACTIVE INGREDIENT IN AQUEOUS SOLUTION, WITH 15%
Mg (NO₃)₂ and 7% MgCl₂ LIQUID CONCENTRATE

<u>Components of the Formulations</u>	% Active Ingrd. (by GLC)		
Form Number	3A	3B	3C ⁶
% AI ²	14.1	14.07	14.0
% Mg (NO ₃) ₂ 6H ₂ O	25.9	25.9	25.9
% MgCl ₂ 6H ₂ O	19.2	19.2	19.2
% "Free" H ₂ O	1.3	0.1	40.9
% Celite 545 ³	29.3	-	-
% Attaclay ⁴ X-250	-	29.9	-
% HiSil ⁵ T-600	10.2	10.8	-
Gauge Pressure at 250°C after 15 hrs at 93°C N/m ² x 10 ⁻³ (psi)	17.8 (2.6)	9.6 (1.4)	82.2-89 (12-13)
Before Gassing Test	13.6	11.4	14
Control	11.5	10.7	13.8

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³Celite 545 available from the Johns-Manville Corporation.

⁴Attaclay X-250 available from the Attapulgus Clay Company.

5 ⁵HiSil T-600 available from the Pittsburgh Plate and Glass Company.

Example 4

There was sealed in bags, or packets or pouches, of the representative porous films, each packet having 20 in.² of surface area (10 in.² on each side), 28.6 gm. of the solid isothiazolone composition produced according to Example 1. The packets are heat-aged three days at 50°C, and one 10 in.² surface of each packet is wiped with a water-dampened tissue to remove any AI residing on the packet's surface. The AI is then extracted from the tissue by 100 ml. of dionized water, and the amount of AI present in the water is determined by ultraviolet spectroscopy by comparing the absorbance at 273 nm with that of a standard solution. The results are as follows:

TYVEK 1621*	0.001 mg./in. ²
TYVEK 1622E*	0.004 mg./in. ²
Cellophane**	0.105 mg./in. ²

* Spunbonded and perforated polyethylene from Dupont.

** Clear film (unperforated) from Olin, #126 PUT-76.

The following words are trademarks which may or may not be registered in some or all of the designated states:

Kathon;	Amberlite;
Celite;	Attaclay;
Micro-Cel;	Hi-Sil;
Aerosil;	Tyvek;
30 Sipernet;	Cellophane.

Solubility parameters are measured by the method of "Polymer Handbook", Brandrup and Immergut, pages IV-344-345, Interscience Publishers 1966.

CLAIMS

1. A microbiocidal article comprising:

(a) a particulate solid microbiocidal composition comprising:

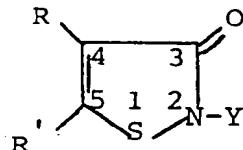
5 (i) 0.1 to 70 weight %, based on total weight of said composition, of water-soluble microbiocide having a room temperature (25°C) water solubility greater than 1000 ppm, blended with and absorbed into;

10 (ii) 99.9 to 30 weight %, based on total weight of said composition, of inert, finely-divided water-insoluble solid carrier material; sealed in

15 (b) a porous membrane of hydrophobic film forming material having a thickness of 1.27×10^{-5} m (0.5 mil) to 25.4×10^{-5} m (10 mils), a solubility parameter less than 12.5 and a pore size smaller than the effective particle size of the solid microbiocidal composition.

2. An article according to claim 1 wherein the membrane comprises polyester, poly(fluoroolefin), polyamides, vinyl chloride polymer, ethylene polymer, propylene polymer, spunbonded poly(ethylene), spunbonded poly(propylene), poly(ethylene terephthalate), or polycarbonate.

20 3. An article according to claim 1 or 2 wherein the microbiocide in the microbiocidal composition comprises microbiocidally-effective isothiazolone, which has a room temperature water solubility of greater than 1000 ppm and is of the formula:



wherein Y is an unsubstituted or substituted C_1-C_{18} alkyl group, an unsubstituted or substituted C_2-C_{18}

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alkenyl or alkynyl group, an unsubstituted or substituted C_3-C_{12} cycloalkyl group, an unsubstituted or substituted aralkyl group of 6-10 carbon atoms, or an unsubstituted or substituted aryl group of 6-10 carbon atoms;

5 R is hydrogen, halogen or a C_1-C_4 alkyl group,
R' is hydrogen, halogen or a C_1-C_4 alkyl group; or
R and R' can be taken together with the C=C bond of the
isothiazolone ring to form a substituted or unsubstituted
benzene ring;
10 or such isothiazolone stabilized with metal salt in an
amount of 1-60 weight %, based on weight of 3-isothiazolone
and metal salt, said metal salt being represented by the
formula:

(MX_n)

15 wherein M is sodium, potassium, calcium, magnesium, copper,
iron, zinc, barium, manganese, silver, cobalt and/or nickel;
X is chloride, bromide, iodide, sulfate, nitrate,
nitrite, acetate, chlorate, perchlorate, bisulfate,
bicarbonate, oxalate, maleate, p-toluene-sulfonate,
20 carbonate, and/or phosphate; and n is an integer for which
the anion X satisfies the valence of the cation M.
4. An article according to any preceding claim wherein the
solid carrier material comprises silicaceous diatomaceous
earth, high water absorption capacity calcium silicate
25 granular material, silica, clay, charcoal, vermiculite, corn
cobs, high purity silica, wood and/or polymeric matrix.
5. An article according to claim 3 or 4 wherein the
microbiocidal composition comprises from 1 to 35 weight %,
based on total weight of composition, of isothiazolone
30 wherein Y is an unsubstituted or substituted C_1-C_{18}
alkyl group or C_3-C_{12} cycloalkyl group; R is hydrogen or
halogen;

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R' is hydrogen or halogen; or R and R' are taken together with the C=C bond of the 3-isothiazolone ring to form a substituted or unsubstituted benzene ring; such isothiazolone stabilized with metal salt(s); and from 99 to 5 65 weight %, based on total weight of composition, of silicaceous diatomaceous earth, high water absorption capacity calcium silicate granular material, silica(s), and/or clay(s) as the solid carrier material.

6. An article according to claim 3, 4 or 5 wherein the 10 microbiocidal composition comprises from 2 to 25 weight %, based on total weight of composition, of isothiazolone wherein Y is methyl, R is hydrogen, and R' is chlorine, such isothiazolone stabilized with $Mg(NO_3)_2$ or a mixture of $Mg(NO_3)_2$ and $MgCl_2$; and from 98 to 75 weight %, based 15 on total weight of said isothiazolone, of silicaceous diatomaceous earth.

7. An article according to any of claims 3 to 6 wherein the microbiocidal composition also comprises, isothiazolone having a room temperature water solubility less than 20 1000 ppm, especially the isothiazolone of solubility about 500 ppm wherein Y is n-octyl or t-octyl and R and R' are each hydrogen, stabilized with $Mg(NO_3)_2$ or a mixture of $Mg(NO_3)_2$ and $MgCl_2$, the total isothiazolone comprising 25 from 2 to 25 weight %, based on total weight of the composition and the combination of isothiazolones having a room temperature water solubility of more than 1000 ppm; and from about 98 to 75 weight %, based on total weight of said composition, of silicaceous diatomaceous earth.

8. An article according to claim 7 wherein the 30 isothiazolone mixture contains isothiazolone wherein Y is methyl, R is hydrogen and R' is chlorine and isothiazolone wherein Y is methyl, R is hydrogen and R' is hydrogen.

9. An article according to any preceding claim wherein the 35 microbiocide is present in the composition in aqueous solution.

10. An article as claimed in any preceding claim wherein the pore size of the membrane is 15.24×10^{-5} m or less, especially in the case of claim 7, preferably about 12.7×10^{-5} m especially in the case of claim 8.
- 5 11. A method of safening a microbiocide which comprises incorporating the microbiocide into an article as claimed in any preceding claim.
- 10 12. A method for controlling living microorganisms in an aqueous system which comprises incorporating into the aqueous system an article according to any of claims 1 to 10.
- 15 13. A method for effecting protracted release of microbiocide into an aqueous system which comprises preparing an article as claimed in any of claims 1 to 10, introducing said article into said aqueous system and allowing the aqueous system to diffuse through the membrane.
- 20 14. A method according to claim 12 or 13 wherein the aqueous system is a metal-working fluid, the contents of a water cooling tower, of a toilet bowl or cistern, of a swimming pool or of a washing machine.



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DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. 3)
Y	US-A-4 105 431 (S.N. LEWIS et al.) * Table 1; examples 7,36,37,38; column 15, lines 29-37; column 19, lines 47-59; column 20, lines 55-62; column 21, lines 13-18; claims 1-14, 25-27 *	1,3,4 9,12- 14	A 01 N 25/34 A 01 N 43/80 C 02 F 1/50 A 01 N 25/32 A 01 N 25/22
D, Y	US-A-4 241 214 (G.A. MILLER et al.) * Table 1; examples 1-17, 21-26; column 14, line 58 - column 15, line 2; column 15, line 64 - column 16, line 13, lines 22-27; claims 1-3 *	1,3-9 12-14	
D, Y	US-A-3 517 022 (G.A. MILLER et al.) * Column 1, line 51 - column 2, line 14; column 7, lines 47-55; column 8, lines 35-42, 61-66 *	1,3-5 9,12- 14	TECHNICAL FIELDS SEARCHED (Int. Cl. 3)
Y	GB-A-1 327 763 (FISONS) * page 1, line 66 - page 2, line 99; page 3, lines 37-55; example 1; claims 1-5, 10-16 *	1,2,9- 14	A 01 N C 02 F
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The present search report has been drawn up for all claims			
Place of search THE HAGUE	Date of completion of the search 18-01-1984	Examiner FLETCHER A.S.	
CATEGORY OF CITED DOCUMENTS		<p>T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document</p>	
<p>X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document</p>			



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Application number

EP 83 30 5578

DOCUMENTS CONSIDERED TO BE RELEVANT			Page 2
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. ³)
D, A	<p>US-A-4 289 815 (P.I. LEE)</p> <p>* Column 4, lines 31-39; column 4, line 64 - column 5, line 28; claims 1,6,8 *</p> <p>-----</p>	1,9,12 -14	
TECHNICAL FIELDS SEARCHED (Int. Cl. ³)			
The present search report has been drawn up for all claims			
Place of search THE HAGUE	Date of completion of the search 18-01-1984	Examiner FLETCHER A. S.	
<p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document</p> <p>T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document</p>			